Calibration/Validation Issues: Microwave Atmospheric Imagery and Soundings

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Outline

- Radiance goals: consistency < ~0.2K (<0.02K for ~54-GHz climate)
- Instrument behavior: sources of error and examples
- Calibration techniques and examples
- Examples: EDR validation and validation issues

Radiance Calibration Goals

- Radiance goals are stressing and beyond current stated requirements
- NOAA/NCEP numerical weather predictions:
  - As 3-D and 4-D variational assimilations improve, random radiance errors must be < ~0.2K rms (to have significant impact)
- Microwave climate observations:
  - Random radiance errors currently < ~0.02K rms for temperature
- Therefore radiance errors are a primary issue (~100-km scale)
- If radiance calibration errors meet goals, then
  - EDR's become primarily an algorithm validation issue
- Therefore the following discussion focuses on radiance calibration

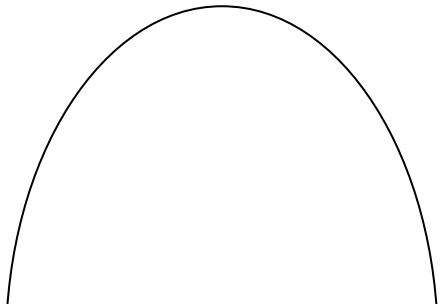
External Sources of Radiance Error, Solutions

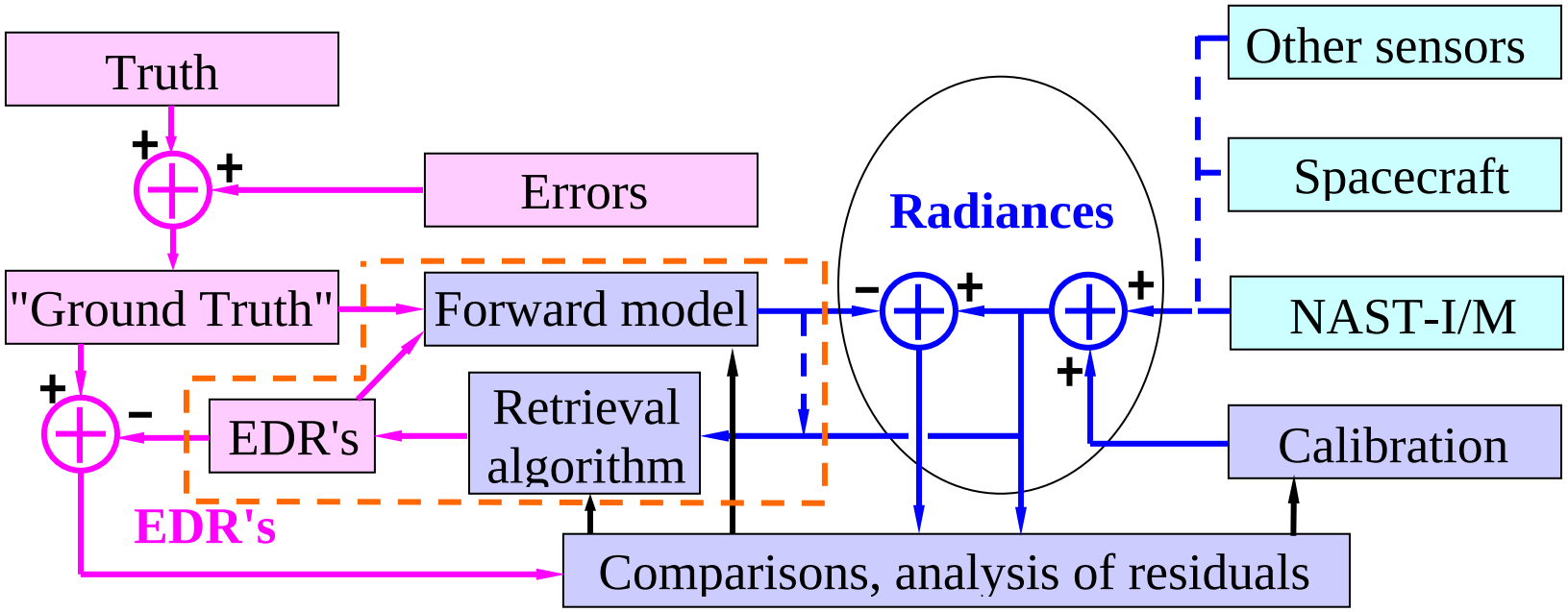
Internal Sources of Radiance Error, Solutions

- **Calibration load emissions:** temperature, environmental reflections
  - Ground-based load emissivity and emission measurements
- **Antenna sidelobes** on earth, spacecraft, sun, moon, space cause errors
  - Therefore observe climate-corrected left-right scan asymmetry
  - Roll spacecraft and use earth and sun as sources in the sidelobes
  - In window channels, use ground-based transmitters to space
  - Ground measurement of sidelobes; calculate and correct radiance errors
- **Antenna polarization errors** (window and mesospheric channels)
  - Observe climate-corrected left-right scan asymmetry (near limb)
  - In window channels, use ground-based transmitters to space
  - Ground measurement of polarization at all scan angles, frequencies
- **RFI from spacecraft** modulated by scanned antenna or spacecraft
  - Observe climate-corrected left-right scan asymmetry
  - Intermittent turn-off of suspected RFI sources (e.g. AMSU-B)
  - Ground measurement of RFI emissions and instrument sensitivity

- **Slow gain and baseline drifts** (temperature drift, aging); therefore:
  - Use 2-point instrument calibration (ambient load and cold space)
  - RAOB, NWP comparisons (opaque channels)
  - Benchmark minimum oceanic brightnesses (ocean T_B has minimum)
  - Cross-instrument, cross-satellite, and aircraft radiance comparisons
- **Rapid gain and baseline drifts** (internal oscillations, calibrator reflections)
  - Raw-count and known-source analyses (e.g., examine uniform fields)
  - Ground analysis of stability, internal reflections (tunable-short test)
- **Single-channel non-linearities and memory**
  - Known-source analyses; cross-instrument, cross-satellite comparisons
- **Inter-channel cross-talk, memory** (e.g. "gain stealing" in broad amplifiers)
  - Correlation patterns in residual radiance errors relative to NWP, etc.
  - Ground analysis of linearities, cross-talk, and memory

Overview of Microwave Cal/Val





- First calibrate instruments and radiances without forward model
- Next calibrate forward model with lab and multiple sensors (e.g. NAST)
- Then modify radiances with minimal use of forward model
- Finally, calibrate retrieval algorithm (use multiple sensors, e.g. NAST)